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PROCEEDINGS OF THE THIRD DAY,

NOVEMBER 23, 1883.

The President, Dr. Robert J. Brown, in the chair. The following papers were read:

COAL-OIL LEGISLATION.

BY H. E. SADLER.

Crude petroleum, or coal oil, consists of a great number of hydrocarbons mixed with or dissolved in each other. They group themselves commercially into three classes, distinguished by a difference in sp. gr., and in melting and boiling points. The refiner separates petroleum into "crude naphtha;" also sold as "gasoline," a mixture of liquids with boiling points ranging from 65° to 250° F.; "kerosene," with boiling points from 250 to 350; and "residuum," boiling at from 350° to 500° or more. Of these the naphtha, composing 15 per cent., is redistilled into three mixtures—"gasoline," with boiling points below 120°; refined naphtha, 120°–175°; and benzine, 175°–250°; and the residuum, amounting to 30 per cent., is reworked for paraffine wax and lubricating oil. The remaining 55 per cent., after being deodorized and perhaps decolorized by acids, &c., is sold for illuminating. The larger establishments commonly "crack" the oil, a process by which the residuum is converted into naphtha, kerosene and coke, and the petroleum so treated yields about 66 per cent. kerosene, 20 per cent. naphtha, the remainder coke and waste. The naphtha is then sold for private air-gas machines, for making oil gas or enriching coal or water gas, for gasoline stoves, extracting oils from seeds, and a constantly increasing number of uses. The demand is not sufficient as yet, however, to make it worth more than about one-fourth as much as kerosene.

As in most cases of fractional distillation, it is impossible to separate the liquids by one boiling. This necessitates a redistillation of at least the lighter portion of the kerosene and the heavier portion of the naphtha, at an increased expense.

This light oil, the by-product of kerosene manufacture, serves well many purposes, but for most of them it is greatly injured by the presence of kerosene. So, too, good kerosene is an ideal burning fluid. It gives a smokeless, white light, equal to eight sperm candles, at a trifling cost, estimated by Professor Chandler as follows:

8-candle sperm light, 42c. per pound,	57.2	mills per hour.
" gas light, \$3 per M,	7.6	" "
" kerosene light, 25c. per gallon,	2.2	" "
" kerosene light, 20c. per gallon,	1.7	" "

At any temperature to which it is likely to be exposed, good kerosene does not take fire, but will extinguish a match or burning wick like water. Unlike naphtha, camphene or coal gas, it forms no explosive mixture with air; and it can contribute nothing to fire except by saturating other combustibles to increase the intensity of their burning. It may even be poured on a red-hot fire with no more danger than attends renewing the coal.

The presence of a small proportion of residuum in the kerosene injures its sale. The color is bad. It soon gums the wick and burns with a dull, yellow, smoky flame. No man can sell you such oil twice. Reputable dealers cannot sell it once. On the other hand, the presence of small quantities of naphtha makes the kerosene burn with a pure white light, rendering traces of residuum less perceptible, and it cannot be detected except by a test of the oil, or, too late, by an explosion. To the refiner, then, the question

of naphtha or none in the oil resolves itself into a question as to whether he shall leave it there to enhance the value of the whole, or, taking it out at considerable expense, throw it away and sell the remainder at a less price; for although the higher-priced oil may ultimately cause loss of property or life, it can rarely be traced home to him. Evidently the refiner, solely interested on the side of danger, is not he to whom it should be left to decide on the safety of our oil.

Two dangers arise from the presence of naphtha in kerosene. When a glass lamp falls it often breaks, and if the oil is adulterated the burning wick, instead of being extinguished, sets fire to the oil as well. This occurrence, however, is rare, and unless the flame extends to the saturated clothing also, is easily controlled. The second danger is that the naphtha evaporating into the air above shall take fire from the wick, or at the approach of some other flame, and exploding with a violence irresistible inflame and scatter broadcast the underlying oil. Such a fire it is next to impossible to fight. By determining to what temperature any oil can be raised before it will give off explosive vapors, we may judge of the liability of the greater disaster. This is called the "flash test." By learning to what further temperature it must be heated before this explosion or flashing of the rising vapor will become persistent or set fire to the surface of the oil itself, we may discover the chances of the lesser accident. This is called the "burning" or "ignition point," or, properly enough, the "fire test;" but for purposes of confusion or through ignorance, this term is variously applied by dealers to denote either the flashing point, the burning point, or the point at which the oil takes fire spontaneously, a temperature practically never reached. Further confusion arises from the fact that different apparatus in use give results varying often by 30°, so that we must know the means of testing, as well as the result, to judge of the oil. The temperature attained in storage or in lamps is commonly stated not to exceed 100 to 110° F. This, however, needs redetermination. If that be so, no oil is safe whose ignition point or flashing point is below 110°. The former is always higher than the latter, usually but by no means necessarily 10° to 30°; so that we cannot assert that oil whose ignition point is as high as 150° is certainly free from danger of explosion, but if the flashing-point be higher than the temperature in the lamp the oil is quite safe.

Inquiry among our dealers indicates that there are four grades of oil sold or quoted in our market, besides some special brands known by a trade-mark. The poorest is "Standard," warranted 115° fire test, whatever that may mean, and worth at the river about 14 cents per gallon. "150° fire test" is a straw-colored oil, worth one to two cents more. "W. W.," or "Water White," also 150° fire test, costs about 19 cents, and is often sold for "Headlight," which is also white, but 175° fire test, and costs 21 cents.

The repeated explosion of a lantern led me to examine some of the oils in use by our students. For this I chose Stoddard's apparatus, checking the results constantly by the New York State tester—a modification of the Wisconsin test—first used by the Michigan Board of Health. This gives results about equal to the average of the testers in common use. The following table shows the tests obtained:

No.	Brand.	Cost retail.	Refiners' fire test.	Flashing point.	Igniting point.
1	Standard,	20c.	115°	88.5°	105.0°
2	150 test,	25	150	86.1	101.2
3	150 test,	25	150	120.5	149.9
4	Water White,	25	150	106.2	131.7
5	Special Brand,	30	150	109.2	132.0
6	Headlight,	30	175	107.8	128.6
7	Headlight,	30	175	108.8	134.0
8	Headlight,	30	175	82.1	102.0
9	Headlight,	30	175	below 50	81.3

Of these it may be remarked that No. 2 was evidently "Standard," sold by mistake or fraud for "150 test." Nos. 6 and 7 were probably "W. W." No. 8 was a fraud, clear and white, but evidently mixed with naphtha; and No. 9, which had already occasioned several explosions, was simply gasoline, sold by mistake for "Headlight." But one of these oils exceeds the bare point of safety, though only three of the nine cost less than 30 cents, and two of the nine could only be used by making certain that neither in lamp or can could their escaping vapors come in contact with flame. Those who knowingly buy cheap oil, cannot perhaps complain; but certainly there can be no excuse for permitting manufacturers or dealers to palm off with impunity highly-dangerous mixtures on those who, willing to pay the highest price, have a right to assume that the oil is at least inexplusive at the temperature of a summer's day. Already in 1882, statutes had been passed by many governments, regulating the character and sale of burning fluids, as may be seen from the following table, taken from Mr. A. H. Elliott's excellent report upon the subject to the New York Board of Health (2d Annual Rept., 1882):

<i>State.</i>	<i>Flashing test.</i>	<i>Fire test.</i>
Canada,	95°	. . . .
England,	100	. . . .
France,	95	. . . .
Japan, . . . . .	. . . .	120°
Sweden,	104	. . . .
Germany, . . . . .	. . . .	104
Georgia, . . . . .	. . . .	110
Illinois, . . . . .	. . . .	150
Indiana,	120	. . . .
Iowa, . . . . .	. . . .	100
Kentucky, . . . . .	. . . .	130
Louisiana,	125	. . . .
Maine, . . . . .	. . . .	120
Maryland, . . . . .	. . . .	110
Massachusetts,	100	110
Michigan,	120	. . . .
Missouri, . . . . .	. . . .	150
New Hampshire, . . . . .	. . . .	120
New York,	100	. . . .
Ohio,	120	. . . .
Pennsylvania, . . . . .	. . . .	110
Vermont, . . . . .	. . . .	110
Wisconsin, . . . . .	. . . .	120
Rhode Island,	110	. . . .

Among our own statutes is one regulating the sale of oil, framed apparently by the manufacturers to prevent action by consumers, and setting forth a fire test in such an indefinite way as to make it impossible to secure a conviction for selling any grade of oil. Besides, it imposes such onerous burdens on the complainant, that so far as I can learn no one has yet had the hardihood to avail themselves of its provisions. A bill presumably in the interests of the people fell flat in our last Legislature; another at the session before. I am well aware that the propriety of such legislation may be called in question. I yield to none in confidence that for our country at least the doctrine of "*laissez faire*" is the only safe policy. I see that since the production and refining of oil have fallen into the hands of one corporation, it bears the appearance of class legislation. I appreciate the inconsistency of permitting the sale of very dangerous gasoline, and prohibiting the less dangerous adulterated kerosene. But on the other hand it must be remembered that kerosene, especially the cheaper grades, is burned chiefly by the ignorant, who cannot protect themselves; that indeed we are all practically without protection except by machinery put in motion by the State; that the use of such oil endangers my neighbor's property equally with my own; and that while it is true that gasoline is more dangerous, so too is powder, but the danger of both is understood and guarded against; and moreover, the gasoline is quite fit for the use to which it is to be

put, while each one should have a right to assume, as all in reality do, that kerosene is fit to store and to burn without unusual precaution.

A word as to what such a statute ought to contain, is in place here. A minimum flash test should be fixed for burning fluids, and regulations formulated looking to the proper storage and consumption of the more volatile oils which are commonly utilized as vapors, and the details referred to this Academy to be settled. A method of inspection and enforcement should be instituted. Finally, the statute should include sufficient appropriations to procure an investigation of the matters connected with the subject which are still obscure, and to carry out its provisions; in short, to make it wisely operative and wisely enforced. Then we may hope to see the last of "Kansas oil." "Why do you call that grade 'Kansas oil?'" I asked the drummer. "Oh, the refiners have to make it or throw the bulk of it into the naphtha, and since they cannot sell it in Missouri, Illinois, Kentucky, Indiana, Ohio, Iowa, or Louisiania, they save it for you, and call it Kansas oil."

ON THE TESTING OF BURNING FLUIDS.

BY H. E. SADLER.

The chief danger from a burning fluid arises from the explosion of its vapor. Explosion of a gaseous mixture takes place when the sum of the available heat units given off by the metathesis of the uniting molecules and the cooling of the products is sufficient to raise all the constituents, active and passive, to the flame temperature.

Whether this sum, definite for a definite mixture at a definite temperature, will be realized, depends on: First, the calorific power of the combustible; second, the quantity of this substance present; and third, the availability of the heat given off by the cooling products.

Elaborate experiments and rules for determining the safety of an oil from its specific gravity, index of refraction, vapor tension, rapidity of evaporation, &c., (M. M. Salleron, *et Urbain*, *An. de Genie Civ.*, V, p. 154, 1866; Hager Wagner's *Jahr.*, XII, p. 674; Pelker Dinger's *Journal*, vol. 189, p. 61; Byasson *Compt. Rend.*, Sept. 4th, 1871, *et al.*), have been shown to be rough but quite unreliable guides. (Engler und Haas' *Zeitschrift für An. Chem.*, XX, pp. 1 and 362.) They all take loose account of the quantity of combustible only, and neglect its heating power and manner of action. The flash test alone seems to take cognizance of all the conditions. This ought to tell us the lowest temperature at which the oil can be made to give off an amount of vapors each of sufficient heating power, so that with the utmost help from the cooling products the whole mixture may be raised to the flame temperature. It is well known that the various testers give results often 30° F. apart; and no one of them constantly gives flashing points, in a series of tests, agreeing within 5°. We are in position now to understand the philosophy of that fact. In an open tester the amount of vapor in the flash chamber will by diffusion be less than in one partly closed, and still less than in one entirely closed. The quality of that which is present will also differ in diffusion, removing the lightest vapors fastest. The availability of heat from the products will also vary. Even if we confine attention to one form of open tester alone, we see that the quantity of vapor is dependent on the temperature of the room, the drafts, the frequency with which the torch is applied, burning up a portion of the vapors already formed, the surface exposed, *i. e.*, the degree to which the oil runs up the sides, the rapidity of heating, the proximity to the oil, and a hundred other conditions which it is impossible to keep constant. The quality of the vapor, too, will vary with the proximity of the oil and the availability of the heat of the products with the drafts, &c., &c.